REMARKS

The Examiner is thanked for his careful and very thorough Office Action.

Claims 1-3 and 5-30 have been rejected.

Rejections Under 35 USC 112, first paragraph

Claims 1-3 and 5-30 are rejected under 35 USC 112, first paragraph, as failing to comply with the enablement requirement.

Because most of the questions raised by the Examiner are not directed towards the present innovations specifically, but rather towards antialiasing in general, Applicant believes that a brief general overview of antialiasing may be helpful.

ANTIALIASING OVERVIEW

As stated in the background of the present application, the process of generating 3D graphics consists of two major stages in the 3D graphics pipeline, geometry and rendering. The geometry stage manages all polygon activities and converts three-dimensional spatial data into a two-dimensional representation of the viewed scene. The rendering stage is responsible for rendering the two-dimensional data from the geometry stage to produce correct values for all pixels of each frame of the image sequence.

Rasterization refers specifically to the steps of the rendering stage that involve determining pixel values from input geometric primitives. A drawback of raster systems arises from the nature of the raster itself. In contrast to a vector system that can draw continuous, smooth lines from essentially any point on the CRT face to another, a raster system can display mathematically smooth lines, polygons, and boundaries of curved primitives only by approximating them with pixels on the raster grid. This approximation can cause the familiar problem of "jaggies" or "staircasing". This visual artifact is a manifestation of a sampling error called aliasing in signal-processing theory. Modern computer graphics is concerned with techniques for antialiasing. These techniques specify gradations in intensity of

neighboring pixels at edges of primitives, rather than set pixels to maximum or zero intensity only.

Antialiasing begins with the creation of subpixel masks of varying intensities for each object that intersects a pixel. There are two general approaches to antialiasing, weighted and unweighted area sampling.

In unweighted area sampling, the intensity is proportional to the percentage of the pixel's tile that the line covers. Setting a pixel's intensity in proportion to the amount of its area covered by the primitive yields a more gradual transition between full on and full off. However, this approach has the disadvantage in that equal areas contribute equal intensity, regardless of the distance between the pixel's center and the area covered. Hence, a small area in the corner of the pixel contributes just as much as an equal-sized area near the pixel's center.

In weighted area sampling, equal areas contribute unequally. A small area closer to the pixel center has greater influence than does one at a greater distance.

These general calculations and determinations can basically be carried out by any computational unit. The Examiner can find a more detailed description of antialiasing in numerous references on computer graphics, such as Computer Graphics Principles & Practice (2.ed. 1990) by Foley *et al.*

THE EXAMINER'S QUESTIONS

Question 1:

With regard to the Examiner's first question, the Examiner has asked how the orientation of the lines is based upon the sampling pattern.

Applicant respectfully submits that the orientation of the lines is not based upon the sampling pattern. Rather, the sampling pattern is chosen based upon the determined orientation of the line. This fact is also reflected in the language of the claims. For example:

claim 1 states, "performing subpixel sampling using one of a plurality of sampling patterns, in dependence on which of said plurality of orientation classes that line falls into";

claim 13 states, "means for performing subpixel sampling using one of a plurality of sampling patterns, in dependence on which of said plurality of orientation classes that line falls into"; and

claim 22 states, "performing subpixel sampling using one of a plurality of sampling patterns, in dependence on which of said plurality of orientation classes that line falls into."

Question 2:

The Examiner has also asked exactly how the lines are classified as x-major or y-major depending on the x or y extent of the line.

Applicant respectfully submits that there are many ways this can be done. One example is given in the present application, namely, by determining whether the line is longer in the x direction or the y direction as stated in paragraph [0014] of the present application, "... lines are classified as x-major and y-major depending whether the x or y extent of the line is larger." This could be accomplished in many ways, such as by determining if the absolute difference between the x coordinates of the line's end points is greater than or equal to the absolute difference between the y coordinates of the line's end points. Another example would be by determining whether the line is more nearly parallel to a vertical or a horizontal line, as Claim 5 teaches. The specific way that the orientation is determined need not be claimed in order to enable one of ordinary skill in the art to make the inventions of the present application.

Question 3:

The Examiner has also asked how the two sampling patterns are implemented.

Applicant respectfully submits that only one sampling pattern is used at a time for a given line, for example, a first pattern for horizontal class lines, a second pattern for vertical class lines. As described in paragraph [0011], antialiasing is accomplished by reducing the contrast between the edge of an object and the color behind it by adjusting pixel values at the edge. One way that this is can be done is by computing samples at "subpixel" locations, within

the area of a single pixel, so that the color values for pixels which overlap an edge are modified in approximate dependence on how many of the samples fall inside the line and how many fall outside of the line.

Question 4:

The Examiner has also asked if the determination of orientation is calculated by summations, logically computed, or software based.

Applicant again respectfully submits that there are many ways this can be done. One example is given in the present application, namely, by determining whether the line is longer in the x direction or the y direction. This could be accomplished in many ways, such as by determining whether the line is more nearly parallel to a vertical or a horizontal line, as Claim 5 teaches. Again, the specific way that the orientation is determined need not be claimed in order to enable one of ordinary skill in the art to make the inventions of the present application.

Question 5:

The Examiner has also asked what elements are doing these calculations.

Applicant respectfully submits that the calculations could be computed anywhere, such as a host processor, a graphics processor, or any other available computational unit. The specific element that can perform the calculations need not be claimed in order to enable one of ordinary skill in the art to make the inventions of the present application.

Question 6:

The Examiner has also asked to what step does the term "wherein said determination is made without the use of an error term or pixel-by-pixel decisions" apply.

Applicant respectfully submits that it applies to the determination step as indicated by the language "wherein said determination", for example, in claims 1, 13, and 22.

PRESENT SPECIFICATION IS ENABLING

The Examiner has suggested that the claimed subject matter of determining which of a plurality of orientation classes an entire line falls into is not described in the specification in such a way as to enable one skilled in the art to make or use the inventions. Applicant respectfully disagrees with the Examiner's suggestion. Paragraphs [0024] to [0027] of the present application state:

> All lines can be classified as x-major or y-major depending whether the x or y extent of the line is larger. A given fixed pattern will normally generate inferior quality for one or other of these line types. One way to fix this is to take more sample points, but this compromises the performance requirements.
>
> The idea in this patent is to use a sub-pixel sampling pattern which is different for x-major and y-major lines. These two patterns are then chosen to optimize the quality of the line type for which they are used. This leads to increased visual quality of the line without adding in more sample points.
>
> FIG. 1 shows an example of using different sampling patterns for x- and y-major lines. Each sample pattern has four sub-pixel points. Four is chosen as this gives good performance.. In the case of the x-major line 102, using a vertical sampling pattern (black dots) shows 2 samples being covered by the line, giving 50% coverage of the pixel. This is a reasonable approximation. For the same line 102 a horizontal sampling pattern (grey dots) gives us no coverage which is incorrect. Similarly, for the y-major line 104, the vertical sampling pattern (black dots) incorrectly gives 100% coverage whereas the horizontal pattern (grey dots) gives reasonably accurate coverage of 75%.
>
> For any arbitrary pattern, line orientations can be chosen that show this pattern favoring either x-major or y-major lines but not accurately handling both. The idea of using two different patterns yields superior anti-aliased results for all lines.[1]

[1] Paragraphs [0024] to [0027].

Of course, this text in the specification is not intended to limit the scope of the claims. It is cited only as an example to explain one embodiment of the present inventions.

Applicant is not claiming to have invented the idea of antialiasing. What Applicant is claiming is an innovative, fast, and economical approach to antialiased rendering with superior anti-aliased results for all lines. This approach as described, for example, in the paragraphs cited above would enable a person of ordinary skill in the art of antialiasing to use the inventions of the present application without undue experimentation.

The Examiner is reminded that specifically, under Section 112, the disclosure must teach a person of ordinary skill in the art how to make and use the invention without undue experimentation. In the disclosure, however, the applicant need not teach what is well known in the art. *Lindemann Machinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 221 U.S.P.Q. 481 (Fed. Cir. 1984); *Staehelin v. Secher*, 24 U.S.P.Q.2d 1513, 1516 (Bd. Pat. App. & Int. 1992). In fact a patent preferably omits what is well known in the art. *Spectra-Physics, Inc. v. Coherent, Inc.*, 827 F.2d 1524, 3 U.S.P.Q.2d 1737 (Fed. Cir. 1987).

For all of the reasons stated above, Applicant respectfully submits that Claims 1-3 and 5-30 are enabling and requests withdrawal of this rejection. If, however, the Examiner still harbors any doubts as to the sufficiency of the disclosure, Applicant will submit an affidavit from one of ordinary skill in the antialiasing art to overcome the rejection based on Section 112, first paragraph.

Art Rejections

The art rejections are all respectfully traversed.

Rejections Under 35 USC 102(b)

Claims 1-3 and 5-8 stand rejected under 35 USC Section 102(b) as anticipated by *Wong et al.*

Claim 1

A method for generating antialiased lines, comprising the actions of:

for each respective line, determining which of a plurality of orientation classes that entire line falls into; and

performing subpixel sampling using one of a plurality of sampling patterns, in dependence on which of said plurality of orientation classes that line falls into;

wherein said determination is made without the use of an error term or pixel-by-pixel decisions.

1. *Wong et al.* does not pick a sampling pattern based upon a line classification.

Instead, as stated in Col. 2, line 55 to Col. 3, line 7 of *Wong et al.*, *Wong et al.* walks an entire edge pixel-by-pixel creating subpixel masks for each object element that is present in the fragmented pixel:

> Generally, the present invention provides a method and apparatus for providing video graphics processing that includes anti-aliasing. This begins when a video graphics processor receives vertex parameters of an object-element (E.g., a triangle) and walks a first edge of the object element (i.e., the left edge of the triangle) and a second edge of the object element (i.e., the right edge of the triangle). The video graphics processor walks the first and second edges based on calculations involving a decision corner and an error term. The calculations indicate which direction to walk on a pixel by pixel basis, i.e., whether the walking should be in the major direction (in the x direction when Δx is greater than Δy or in the y direction when Δy is greater than

> Δy), or the minor direction (in the y direction when Δx is greater than Δy or in the x direction when Δy is greater than Δx). The calculations also identify pixels that contain fragment pixel information, i.e., the pixels along the edges of the object element. For each fragment pixel subpixel masks are created for each object element that is present in the fragmented pixel.

Accordingly, *Wong et al.* does not classify an entire line or use sampling patterns. There does not appear to be a need to classify the entire line or to use a sampling pattern when *Wong et al.* walks the entire edge pixel-by-pixel as it creates subpixel masks for each object element that is present in the fragmented pixel. Therefore, *Wong et al.* clearly does not pick a sampling pattern based upon a line classification.

2. *Wong et al.* does not appear to classify the entire line.

Specifically, claim 1 recites, "for each respective line, determining which of a plurality of orientation classes that entire line falls into." As stated in Col. 11, lines 54-66 of *Wong et al.* cited by the Examiner, *Wong et al.* does not appear to determine the classification the entire line:

> ... If the slope is less than a threshold value (E.g. 0 for this example), the walking continues along the major axis (in this example, along the Y-axis). To determine the error term at pixel location (6,6), which is the next pixel along the left edge, the minor component of the slope is added to the error term of pixel (6,5). As shown, the error term at (6,6) is still less than one pixel, so the edgewalker circuit walks the left edge along the major direction. Walking in the major direction continues as long as the error term remains below the threshold. Once the error term exceeds the threshold, which it does at pixel location (6,8), the walking of the edge switches to walking in the minor direction.

Wong et al. uses an error term to determine in which direction to walk. The Examiner correctly notes, "Wong et al. uses the difference in length between the major axis and the edge to decide if and when to walk in the minor direction."

This determination is made on a pixel-by-pixel basis. Again, there does not appear to be a need to classify the entire line when *Wong et al.* walks the entire edge pixel-by-pixel creating subpixel masks for each object element that is present in the fragmented pixel.

Edge walking and pixel-by-pixel calculation may result in high quality antialiased lines but at the high cost of speed. As stated in paragraph [0023] of the present application:

> Anti-aliased lines have two conflicting requirements: speed and quality. For high speed (or low gate cost) the number of sub-pixel samples needs to be kept low, but for high quality the more sub pixel samples the better. A single fixed pattern of samples is usually chosen for all lines. This has the disadvantage that a given pattern will lead to varying quality across lines of different orientations. For example, a given pattern may generate good quality for vertical lines, but be lead to lower quality for horizontal lines.

The present application does not require the use of pixel-by-pixel calculations or the use of an error term or threshold value. The present inventions make a LINE-BY-LINE determination. This allows for fast and economical antialiased rendering with superior anti-aliased results for all lines. This approach is computationally less expensive and leads to **increased visual quality of the line without adding in more sample points**.

3. *Wong et al.* does not perform subpixel sampling using sampling patterns.

Claim 1 also recites, "performing subpixel sampling using one of a plurality of sampling patterns, in dependence on which of said plurality of orientation classes that line falls into." *Wong et al.* does not perform subpixel sampling using sampling patterns.

With regard to this limitation, the Examiner has only suggested that, "the office interprets the subpixel masks substantially similar in functionality to the sampling patterns of applicant's claims and also believes the further processing of subpixel masks, discloses above by *Wong et al.*, to be

substantially similar to the sampling of subpixels." Applicant respectfully disagrees with this suggestion.

The teaching in *Wong et al.* does not teach, "performing subpixel sampling using one of a plurality of sampling patterns, in dependence on which of said plurality of orientation classes that line falls into." As stated earlier in the overview of antialising, sampling pixels and generating subpixel masks are two entirely different steps in the rendering process. Accordingly, sampling patterns are not the same as subpixel masks. Sampling patterns are used to determine subpixel masks. Also, the further processing of subpixel masks is not substantially similar to the sampling of subpixels.

The Examiner is respectfully reminded that a prior art reference anticipates the claimed invention under 35 U.S.C. § 102 only if every element of a claimed invention is identically shown in that single reference, arranged as they are in the claims. *In re Bond,* 910 F.2d 831, 832, 15 U.S.P.Q.2d 1566, 1567 (Fed. Cir. 1990).

4. *Wong et al.* does not appear to classify the entire line, much less without the use of an error term or per pixel decisions.

Claim 1 also recites, "wherein said determination is made without the use of an error term or per pixel decisions." As stated in Col. 11, lines 54-66 of *Wong et al.* cited by the Examiner, *Wong et al.* does not classify the entire line and requires the use an error term to determine in which direction to walk. This determination is made on a per pixel basis:

> ... If the slope is less than a threshold value (E.g. 0 for this example), the walking continues along the major axis (in this example, along the Y-axis). To determine the error term at pixel location (6,6), which is the next pixel along the left edge, the minor component of the slope is added to the error term of pixel (6,5). As shown, the error term at (6,6) is still less than one pixel, so the edgewalker circuit walks the left edge along the major direction. Walking in the major direction continues as long as the error term remains below the threshold. Once the error term exceeds the threshold, which it does at pixel location (6,8), the walking of the edge switches to walking in the minor direction.

Accordingly, this element of Claim 1 is also not shown or suggested by *Wong et al.* and is not addressed by the Examiner.

Therefore, for all of the reasons stated above, Applicant respectfully submits that Claim 1 is not anticipated by *Wong et al.*

<u>Claim 5</u>

A method for antialiased rendering, comprising the actions of:

(a) identifying, for at least one respective entire line, which one of a limited number of directions is most nearly parallel to said line; and

(b) performing subpixel sampling on said line with a subpixel sampling pattern which has maximal resolution approximately normal to said one direction;

wherein said identification is made without the use of an error term or pixel-by-pixel decisions.

5. *Wong et al.* does not determine which direction is most nearly parallel to the entire line.

Claim 5 also recites elements not shown or suggested by *Wong et al.* Specifically, Claim 5 recites, "identifying, for at least one respective entire line, which one of a limited number of directions is most nearly parallel to said line."

With regard to this element, the Examiner has suggested that:

> … the office interprets that the edge walking of Wong et al. substantially determines a direction which is most nearly parallel to a line segment of an object since the edge walking of Wong et al. uses the difference in length between the major axis and the edge (see "error terms" of Figure 6) to decide if and when to walk in the minor direction.

Applicant respectfully disagrees with the Examiner's suggestion. *Wong et al.* does not determine which direction is most nearly parallel to the

ENTIRE LINE. *Wong et al.* merely walks along the edge determining which direction is most parallel to EACH PIXEL. This is not the same thing as determining which direction is most nearly parallel to the ENTIRE LINE.

6. *Wong et al.* does not perform subpixel sampling on a line using sampling patterns which have maximal resolution approximately normal to said line.

Claim 5 also recites, "performing subpixel sampling on said line with a subpixel sampling pattern which has maximal resolution approximately normal to said one direction."

With regard to this element, the Examiner has suggested that:

> ... since Wong et al. discloses determining different subpixel masks, which are then processed to produce pixel information for a given pixel (see column 1, lines 38-38), dependent upon the changes in the X and Y traversed directions (see columns 12-13, lines 53-9 and Figure 9), the office interprets the subpixel masks having maximal resolution normal to the direction they're calculation is based upon (i.e. major direction) versus the opposite direction (i.e. minor direction).

However, Applicant would like to point out again that sampling pixels and generating subpixel masks are two entirely different steps in the rendering process. Accordingly, sampling patterns are not the same as subpixel masks. Rather, sampling patterns are used to determine subpixel masks. Also, the further processing of subpixel masks is not substantially similar to the sampling of subpixels.

7. *Wong et al.* does not determine which direction is most nearly parallel to the entire line, much less without the use of an error term or per pixel decisions.

The present invention in Claim 5 also recites, "wherein said identification is made without the use of an error term or per pixel decisions."

As stated earlier, *Wong et al.* does not appear to determine which direction is most parallel to the entire line. *Wong et al.* merely uses an error

term to determine in which direction to walk. This determination is made on a per pixel basis. Accordingly, this element of Claim 5 is also not shown or suggested by *Wong et al.* and is not addressed by the Examiner.

Therefore, for all of the reasons stated above, Applicant respectfully submits that Claim 5 is not anticipated by *Wong et al.*

<u>Claims 2-3 and 6-8</u>

Finally, dependent Claims 2-3 and 6-8, which depend directly from independent Claims 1 and 5 and incorporate all the limitations thereof, also include additional limitations that are not shown or suggested by *Wong et al.*

Specifically, Claim 2 recites, "wherein said classes consist of x-major and y-major."

With regard to this limitation, the Examiner has suggested that the edge walking process disclosed by *Wong et al.* operates in the two directions of X and Y. However, as stated above, *Wong et al.* does not appear to classify the entire line, much less by x-major and y-major classes. There does not appear to be a need to classify the entire line when *Wong et al.* walks the entire edge pixel-by-pixel creating subpixel masks for each object element that is present in the fragmented pixel.

Claim 3 recites, "wherein said orientation classes correspond one-to-one to said sampling patterns."

With regard to this limitation, the Examiner has suggested, "Wong et al. discloses the creation of the subpixel masks to be dependent upon the slope of the previous direction taken or the orientation of the line determined by edge walking." Again, Applicant respectfully submits that sampling pixels and generating subpixel masks are two entirely different steps in the rendering process.

Claim 6 recites, "wherein said number of directions is two."

With regard to this limitation, the Examiner has suggested, "Wong et al. discloses the edge walking process to operate in the two directions of X and

Y." However, as stated earlier, *Wong et al.* does not appear to determine which direction is most parallel to the entire line. *Wong et al.* merely uses an error term to determine in which direction to walk. This determination is made on a per pixel basis.

Thus, for all of the reasons discussed above, Applicant respectfully requests withdrawal of this rejection.

Conclusion

Thus, all grounds of rejection and/or objection are traversed or accommodated, and favorable reconsideration and allowance are respectfully requested. The Examiner is requested to telephone the undersigned attorney or Patrick C. R. Holmes for an interview to resolve any remaining issues.

Respectfully submitted,

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